

THE ECONOMIC IMPACT OF OIL
IMPORT REDUCTIONS

PREPARED AT THE REQUEST OF

HENRY M. JACKSON, *Chairman*

COMMITTEE ON ENERGY AND
NATURAL RESOURCES
UNITED STATES SENATE



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MEMORANDUM OF THE CHAIRMAN

To Members of the Senate Committee on Energy and Natural Resources:

Earlier this year, the committee asked the Congressional Budget Office to analyze the possible economic impacts of future interruptions of oil imports, accompanied by oil price increases. This report, prepared in response to that request, makes clear that such interruptions and price increases would have a significant impact on the U.S. economy.

The report underscores the significance of an effective strategic reserve, and the importance of an equitable allocation system to minimize the disruptions caused by oil import shortfalls and price increases. Specifically, it concludes that a 500 million barrel reserve could avert an additional \$20 billion loss in real GNP in 1982 if a reduction in imports of 3 million b/d occurred in that year.

By assessing the economic costs of supply interruptions and price increases, this report will be helpful to Congress in evaluating the strategic reserve and other programs designed to minimize these costs. The report does not purport to deal with the longer-term political and economic consequences of U.S. dependence on foreign oil. The recent cartel price increases and the current situation in Iran have once again reminded us that our growing reliance on oil imports is politically unwise and economically unsound. As a Nation, we will ignore these new warnings at our peril.

The committee is grateful to the Congressional Budget Office for its cooperation in the preparation of this report.

HENRY M. JACKSON, *Chairman.*

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PREFACE

The threat of another foreign oil production limitation and price increase has been a major concern of U.S. energy policy since the 1973-74 oil crisis. This report, prepared at the request of the Senate Energy and Natural Resources Committee, examines both the impact on the economy of another supply interruption and the effectiveness of a series of policy options, such as the strategic petroleum reserve and oil allocation regulations, for minimizing that impact.

"The Economic Impact of Oil Import Reductions" was written by Robert F. Black of the Congressional Budget Office's Natural Resources and Commerce Division, under the general direction of Raymond C. Scheppach and Richard D. Morgenstern. Special thanks go to Bill Finan and George Schink of Wharton Econometric Forecasting Associates for providing technical assistance for this project. Marion F. Houstoun edited the manuscript, which was typed for publication by Misi Lenci. In accordance with CBO's mandate to provide objective and nonpartisan analysis, this paper contains no recommendations.

ALICE M. RIVLIN, *Director.*

December 1978.

CONTENTS

	Page
Memorandum of the Chairman.....	(iii)
Preface.....	(v)
Summary.....	1
Chapter I. Introduction.....	5
Chapter II. Framework for analyzing a future oil production limitation and price increase.....	7
Recent changes in U.S. oil imports and energy policy.....	7
The analytic framework.....	7
Duration and magnitude of an oil production limitation.....	8
World oil prices during an oil production limitation.....	9
Strategic petroleum reserve.....	9
Allocation regulations.....	10
Price controls on oil.....	10
Chapter III. Macroeconomic effects and policy implications.....	13
Macroeconomic effects.....	13
Effects during the interruption.....	13
Effects after the interruption.....	14
Impact of SPR and petroleum allocation regulations.....	15
Effectiveness of petroleum allocation regulations.....	16

APPENDIXES

APPENDIX A

Description of the Wharton annual energy model.....	21
Introduction.....	21
Input-output analysis of a foreign oil production cutback.....	21

APPENDIX B

Development of assumptions regarding oil import reduction levels.....	29
Forecast of future U.S. oil imports.....	29
OAPEC share of U.S. imports.....	29
Financial condition of OAPEC countries.....	30
Oil import reduction levels.....	30

TABLES

Table 1. Summary of analytic framework for a hypothetical yearlong oil production limitation and price increase in 1982.....	8
Table 2. Impact of a yearlong oil production limitation in 1982 on GNP, unemployment, and inflation during the supply interruption.....	14
Table 3. Impact of a yearlong oil production limitation in 1982 on real GNP, unemployment, and inflation in 1985.....	14
Table 4. Impact of strategic petroleum reserve (SPR) on real GNP during a 3 and 4 MMBD oil supply interruption in 1982.....	15
Table 5. Impact of strategic petroleum reserve on unemployment during a 3 and 4 MMBD oil supply interruption in 1982.....	16
Table 6. Impact of an 8-percent petroleum shortfall in 1982 on major sectors of the economy during the supply interruption.....	17

VIII

APPENDIX TABLES

	Page
Table A-1. Simple input-output accounting example.....	21
Table A-2. Simple input-output accounting example with expanded final demand.....	22
Table A-3. Simple input-output table in coefficient form.....	22
Table B-1. OAPEC share of U.S. oil imports.....	29
Table B-2. Financial condition of OAPEC countries, 1973 and 1977.....	30
Table B-3. Derivation of 3 MMBD case.....	30
Table B-4. Derivation of 4 MMBD case.....	31

FIGURES

Figure A-1. Basic input-output structure.....	22
Figure A-2. Direction of solution of input-output relationships.....	23
Figure A-3. Direction of solution of price relationships.....	24
Figure A-4. Income and price effects.....	24

SUMMARY

BACKGROUND

The Arab oil production limitation and quadrupling of oil prices, which occurred from October 1973 to March 1974, significantly affected the American economy. In the aftermath, real GNP and income decreased by several percent and, by 1975, unemployment increased by almost 2 percent. Perhaps even more significantly, the rate of inflation accelerated, causing major adjustment problems during the next several years. These aggregate effects do not, however, tell the whole story: certain industries, firms, and individuals experienced considerable hardship during this 5-month crisis, which is difficult to measure in terms of economic loss.

The severity of that oil supply interruption provided a major impetus for legislation designed to mitigate the impact of another oil production limitation and price increase. In fact, reducing the dependence of the U.S. economy on foreign oil imports is a major objective of most recently proposed energy legislation. Although it is extremely difficult to determine the probability of the occurrence of another oil production limitation, in developing future energy policies it is important to assess the likely impact of another supply interruption on the economy. This is particularly true at the present time, because both the level and source of U.S. oil imports, as well as Federal policies designed to mitigate an oil supply interruption, have changed markedly since 1973.

Since the 1973-74 crisis, U.S. imports of crude oil and products have increased sharply, from 6.2 million barrels a day in 1973 (36 percent of total U.S. oil consumption) to 8.6 million barrels a day in 1977 (47 percent of total U.S. oil consumption). Not only have total oil imports increased, but U.S. dependence on the countries that imposed the previous supply limitation—the Organization of Arab Petroleum Exporting Countries (OAPEC)—has increased dramatically, from 8 to 21 percent of total domestic oil consumption between 1973 and 1977.

Government policy has also changed significantly since 1973. A strategic petroleum reserve (SPR), aimed at offsetting the likely output losses associated with a cutback, is now being filled; the Department of Energy (DOE) estimates it will contain 500 million barrels by 1980. New regulations allocating oil in the event of another production cutback are also currently being considered by DOE. In addition, the fact that the President no longer has clear-cut authority to invoke mandatory economywide price controls—as he did in 1973-74—could also affect the severity of another foreign oil supply interruption.

This report analyzes the macroeconomic effects of alternative levels of OAPEC oil export restrictions and the effectiveness of the U.S. strategic petroleum reserve in mitigating those effects. Four cases are considered. Each case assumes that a yearlong oil supply interruption occurs in 1982, with oil import prices remaining constant in real

terms before that year, at which point they increase by 20 percent. The petroleum allocation regulations now being considered by the Department of Energy and price controls on oil-related products are also assumed to be in effect.¹ Within the framework of those common assumptions, the report examines the impact of oil import reductions of 3 or 4 million barrels a day (mmbd) and an SPR of 250 or 500 million barrels, representing an 8, 11, 13, and 16 percent net reduction, respectively, in the total amount of oil available for U.S. consumption.

THE EFFECTS OF AN OIL SUPPLY INTERRUPTION AND THE EFFECTIVENESS OF THE STRATEGIC PETROLEUM RESERVE

An oil production limitation and price increase of the duration and size assumed above would have a significant, but not a devastating, impact on the U.S. economy. The policy options available to the Federal Government could, however, offset some of those effects. The strategic petroleum reserve would help mitigate output losses and a system of petroleum allocation regulations would help insure the production of vital national goods and services; thus, both of these policy options would diminish the adverse impact of a foreign oil production limitation and price increase on the U.S. economy.

Output and employment effects.—As with most economic shocks, the impact of another oil production limitation and accompanying price increase would be greatest during the year in which it occurred. Nevertheless, the level of GNP and employment would also be affected during the next several years. With a 500-million-barrel SPR, the imposition of a yearlong 3-mmbd oil cutback (which would represent approximately an 8-percent reduction in domestic oil consumption, or about half the reduction experienced during the 5-month interruption in 1973–74) would reduce real output in the United States by 2.9 percent and increase the unemployment rate by 1 percentage point above the levels forecast for 1982. An oil restriction of this nature would also reduce real output over the next several years; for example, in 1985, real output would still be 0.7 percent below, and unemployment would be 0.5 percent above, the base case.

If the oil import restriction were increased, so that the net impact was roughly equivalent to the 16-percent shortfall in oil supply experienced during the 1973–74 interruption—that is, in the case of a 4-mmbd oil reduction and a 250-million-barrel SPR—output would be reduced by 9.8 percent and the unemployment rate would be 3.2 percent above the base case level in 1982. By 1985, output and employment would still be .8 and 1 percent, respectively, below that projected without an oil cutback. In short, a larger oil supply reduction (a 16-percent shortfall) has a proportionately greater effect on GNP than a smaller reduction (an 8-percent shortfall), because of the limits that conservation and fuel switching have on mitigating output losses.

Price effects.—Although all the cases considered in this analysis assume that allocation regulations and price controls on petroleum products would be in effect, the 20-percent price increase on non-OAPEC crude oil and the oil supply shortfall cause significant in-

¹ Despite the current lack of authority for mandatory price controls, this analysis assumes they would be in effect in the event of an oil supply interruption because an oil price increase, when coupled with shortages in sectors of the economy that use petroleum, would cause serious short-run problems.

creases in the general price level. For example, a 3-mmbd reduction and a 500-million-barrel SPR would increase general prices in 1982 by 1.3 percent; a 4-mmbd reduction and a 250-million barrel SPR would increase prices by 4.3 percent. Similarly, in 1985, prices would still be .7 and .1 percent, respectively, above that expected without an oil cutback.

Strategic petroleum reserve.—A strategic petroleum reserve would offset some of the economic disruptions caused by an oil supply reduction and price increase. In particular, with a 3-mmbd oil reduction, an SPR level of 500 million—as opposed to 250 million—barrels would avert an additional \$20 billion loss in real GNP in 1982. That would represent a net real output savings of about \$80 per barrel of reserve, and there would be additional output loss protection during the next several years. In the case of a 4-mmbd interruption, each barrel in storage above 250 million would avert \$172 in real GNP loss in 1982, with some additional offsets during the next several years. Those savings in output losses would also be translated into the saving of 430,000 and 960,000 jobs, respectively. The SPR would also provide a limited amount of price inflation protection. Nevertheless, in making actual decisions about the rate at which the strategic petroleum reserve should be filled, these potential benefits must be balanced against its total cost and the probability of another oil supply interruption.

Allocation regulations.—Regulations that would allocate petroleum products across industries during a petroleum shortfall do appear to provide some protection to sectors of the economy deemed vital to the national interest in the Emergency Petroleum Allocation Act of 1973. In general terms, this means that agriculture, utilities, health services, and other industries would suffer proportionally less employment and output loss than durable and nondurable goods, construction, and wholesale/retail trade.

A FINAL REMARK

The data provided in this paper on the output, employment and inflationary effects of alternative oil supply shortfalls are meant to provide only estimates of the short-run vulnerability of the U.S. economy to the current level of foreign oil dependence. These estimates, when coupled with implementation costs and an assessment of the probability and size of another oil supply interruption and price increase, should be helpful to the Congress as it decides the rate at which the strategic petroleum reserve should be filled. More importantly, however, it provides background information on some of the potential risks associated with the current high level of oil consumption by the United States and, particularly, its increasing dependence on foreign oil. The other major risks, which are not considered in this analysis, are the possibility of a long-term world oil shortage, a continuing devaluation of the dollar, and the extent to which U.S. national security and international relations are jeopardized by this oil dependency. These and other risks will be assessed by the Congress as it debates additional proposed energy legislation during the next session. The potential economic effects of another oil supply curtailment and price increase, as addressed in this paper, represent one aspect of that debate.

CHAPTER I. INTRODUCTION

Reducing the vulnerability of the U.S. economy to another oil production limitation and price increase is a major objective of most recently proposed energy legislation. What would be the impact on the economy of another worldwide production limitation, stemming from either a political event or from a foreign oil production bottleneck? What policies are available for mitigating its macroeconomic effects on the United States?

In order to understand the dynamics of any future oil production limitation, it is useful to review the 1973-74 crisis. The Arab oil supply interruption, which occurred from October 1973 to March 1974, resulted in approximately a 15-percent reduction in the amount of petroleum available to the U.S. economy.¹ This reduction in petroleum supplies and the subsequent quadrupling of oil prices affected all sectors of the economy. The oil reduction led to the allocation of existing supplies of such petroleum products as gasoline and home heating oil to consumers, which led to shortages in some sectors of the economy. These shortages, in turn, caused consumer prices to rise in many sectors of the economy. Higher energy prices raised the cost of almost every commodity and service consumed. Furthermore, price hikes led to an increase in wage levels, which further aggravated inflationary pressures.

Real growth and unemployment were also adversely affected by the oil supply interruption. In many industries, the reduced supply of petroleum forced factories to decrease their hours of operation or, in some cases, to close down. This situation was especially pronounced in the automobile industry, where falling demand for cars caused auto manufacturers to cut back production and lay off large numbers of workers. Finally, because consumers could not easily reduce their use of gasoline or home heating oil when the price increased, higher petroleum prices forced consumers to spend more of their income on energy. As a consequence, less income was available for other goods and services, so the demand for other products dropped, and real output and employment fell.

Although it is extremely difficult to quantify the impact of the 1973-74 crisis on the U.S. economy, a number of studies, using a variety of approaches, have attempted to assess the economic impact of that oil production limitation and price increase.² The most recent analysis of

¹ Randall G. Holcombe, "A Model Estimate of the Economic Impact on an Interruption in the United States Petroleum Imports" (final report for the Federal Energy Administration, April 1976).

² See for example, Federal Energy Administration, "Project Independence Report" (1974), and Federal Energy Administration, "Report to Congress on the Economic Impact of Energy Actions" (1976).

the 1973-74 oil crisis, undertaken by Data Resources Inc., concluded the following:

- The oil price increase added nearly 1.8 percentage points to the U.S. inflation rate in 1974 and 1975;
- By 1975, the energy crisis had raised the unemployment rate by 1.7 percentage points; and
- Real GNP was reduced by 3 percent in 1974.³

A number of Government policies were pursued in response to this oil production limitation and price increase. In the first place, Phase IV price controls and a voluntary petroleum allocation program were in effect even before the production cutback. On November 1, 1973, the Nixon administration implemented a mandatory allocation program for middle distillates. During that same month, the Congress enacted the Emergency Petroleum Allocation Act (EPAA), which required promulgation of mandatory petroleum allocation regulations. The Phase IV price controls and the mandatory petroleum allocation regulations formed the heart of the Government response to the crisis. The regulations, which gave priority to food, defense, emergency services, and fuel production, covered all petroleum products and directed their allocation from refining to end-use, with the exception of gasoline, which was allocated at the wholesale level. Finally, in December 1973, the Federal Energy Office was created to deal with the energy crisis caused by the production cutbacks.

An oil supply interruption and resulting price increase in the early 1980's could likewise reduce real growth and cause substantial inflation. The severity of such a crisis would, however, be affected not only by the duration and magnitude of a foreign oil supply interruption, but also by the policies pursued by the U.S. Government. Notwithstanding the common belief on the part of the American public that another foreign oil supply interruption and price increase would be disastrous to the American economy, a number of Federal policies, such as the strategic petroleum reserve, oil allocation regulations, and price controls on oil-related products, could help minimize the short-run economic problems that are likely to result from a foreign oil supply interruption.

The objectives of this background paper are thus twofold. On the one hand, it attempts to determine the impact of a new oil production limitation and price increase on the U.S. economy in general and on particular sectors of it. On the other hand, however, the analysis also attempts to assess the effectiveness of several policy options available to the Federal Government for minimizing the economic effects that are likely to be associated with a supply interruption. Thus, this analysis provides background information for the Congress on some of the possible risks of a continuing U.S. dependence on foreign oil. A long-term world oil shortage, a continuing devaluation of the dollar, and the constraints on U.S. foreign policy generated by that oil dependency are other major risks which, while not analyzed in this paper, are also associated with the current high level of oil consumption by the United States and its increasing dependence on oil imports.

³ Data Resources Inc., U.S. Long-term Review, "1980 Oil Embargo Study" (fall 1977), p. 2.

CHAPTER II. FRAMEWORK FOR ANALYZING A FUTURE OIL PRODUCTION LIMITATION AND PRICE INCREASE

RECENT CHANGES IN U.S. OIL IMPORTS AND ENERGY POLICY

In the years since the 1973 crisis, significant changes, which could alter the effect of another Arab oil production limitation and price increase, have taken place in the level and source of oil imports and in Government policy.

The volume of U.S. oil imports has significantly increased since 1973. In 1973, refined and crude imports totaled about 6.2 million barrels a day, which represented 36 percent of total U.S. oil consumption; by 1977, U.S. imports amounted to 8.6 million barrels a day, or 47 percent of U.S. oil consumption. Moreover, the countries responsible for the 1973 oil supply interruption now provide a much larger share of U.S. petroleum imports than they did at that time. In January through September 1973, the Organization of Arab Petroleum Exporting Countries (OAPEC)¹—the world's major oil producers—provided the United States with 23.6 percent of its total oil imports, which constituted 8.4 percent of domestic oil demand. But, by September 1977, OAPEC's share of U.S. oil imports had risen to 42 percent, or 20.5 percent of domestic demand.² This shift in supply reflects a U.S. demand for light, low-sulfur, crude oils, which provide a higher volume of gasoline and fuel oil from distillation than does heavy crude oil.³

Government policy has also changed since the 1973-74 crisis. Clearly, one of the most significant changes was the decision to build a strategic petroleum reserve (SPR), aimed specifically at minimizing the output losses associated with a production limitation. Petroleum allocation regulations have also been developed and tested. But, unlike the 1973-74 period and despite the fact that, without a modified form of price controls on oil-related products, the economy would face a number of serious short-run problems in the event of another oil supply interruption, the President today has no clear-cut authority to invoke mandatory economywide price controls.⁴

THE ANALYTIC FRAMEWORK

In order to analyze the macroeconomic impact of future oil supply interruptions and assess the effectiveness of the strategic petroleum reserve, a framework was developed incorporating data regarding the

¹ The OAPEC nations involved in the supply interruption were Algeria, Egypt, Kuwait, Libya, Qatar, Saudi Arabia, Syria, and the United Arab Emirates.

² "OPEC Share of U.S. Petroleum Imports Still Increasing," *Oil and Gas Journal*, vol. 76 (May 15, 1978), p. 49.

³ Data Resources Inc., "1980 Oil Embargo Study," p. 2.

⁴ Another change in Government policy, which is not specifically examined in this analysis, is the development of the International Energy Agency.

1973-74 experience, the changing oil import position of the United States, and energy policy changes that have occurred since 1973. Table 1 specifies the key variables central to the analysis of any future oil production limitation and price increase. All of these assumptions were then integrated into the Wharton annual energy model, which was utilized to carry out the analysis. (Details concerning the Wharton annual energy model can be found in Appendix A.)

Four particular cases are examined within this framework. In all of the cases, oil import prices are assumed to remain constant in real terms before a yearlong oil supply interruption in 1982, when oil import prices are assumed to increase by 20 percent. The analysis also assumes that price controls on oil-related products and oil allocation regulations would be in effect and would be identical in all four cases. Within the framework of those common assumptions, the macroeconomic effects of a yearlong 3-million-barrels-a-day (mmbd) oil production cutback are analyzed on the assumption of a strategic petroleum reserve level of 500 million barrels (case 1, a resulting petroleum shortfall of 8 percent) and on the assumption of an SPR level of 250 million barrels (case 2, an 11-percent shortfall). The effects of a 4-mmbd production cutback with an SPR level of 500 million barrels (case 3, a 13-percent shortfall), and with an SPR of 250 million barrels (case 4, a 16-percent shortfall) are similarly analyzed. Each of the key variables affecting the magnitude of a future oil supply interruption are discussed in subsequent sections of this chapter.

TABLE 1.—SUMMARY OF ANALYTIC FRAMEWORK FOR A HYPOTHETICAL YEARLONG OIL PRODUCTION LIMITATION AND PRICE INCREASE IN 1982

Key variables	Case 1	Case 2	Case 3	Case 4
Amount of oil supply reduction (millions of barrels a day).....	1 3	1 3	2 4	2 4
Percent increase in oil prices.....	20	20	20	20
Strategic petroleum reserve level (millions of barrels).....	500	250	500	250
Allocation regulations.....	(3)	(3)	(3)	(3)
Price controls.....	(3)	(3)	(3)	(3)
Resulting petroleum shortfall (percent) ⁴	8	11	13	16

¹ Represents 7 percent of total U.S. energy consumption in 1982.

² Represents 10 percent of total U.S. energy consumption in 1982.

³ In place and identical in all 4 cases.

⁴ Represents the amount of petroleum lost to the U.S. economy in 1982 after accounting for SPR.

Duration and Magnitude of an Oil Production Limitation

Both the duration and the magnitude of an oil production limitation will affect the severity of another oil crisis. Although the 1973-74 Arab oil production limitation and price increase lasted for only about 5 months, in order to determine the maximum effects of an oil supply interruption on the economy, this analysis assumes it will last 1 year.

In order to provide a range of results and to test their sensitivity, two further assumptions about the reduction in oil supplies were made. The first case assumes that the United States would face an oil import reduction of 3 million barrels a day, representing approximately 7 percent of total U.S. energy consumption in 1982. The second case assumes oil imports would be reduced by 4 million barrels a day, or about 10 percent of total energy consumption. Although a number of events could cause oil reductions of that magnitude (for example, a fire in the Persian Gulf), this analysis assumes a situation analogous to the 1973-74 supply interruption, when the major OAPEC nations

imposed a production cutback. Thus, the analysis assumes that the remaining OPEC countries as well as such other exporting countries as Mexico and Canada would not participate in the production cutback.

These two assumptions regarding the probable level of a future oil import reduction were developed, first, by surveying various forecasts of future U.S. oil imports, in order to obtain a reasonable range of possible oil imports for the early 1980's. The historical relationship between U.S. oil imports and OAPEC countries was then examined. Finally, the international reserve position of the key OAPEC nations was reviewed to determine their ability to limit oil production without suffering financial difficulties. These factors were then integrated together to obtain the oil import reduction levels used in the analysis. (See Appendix B for details on how these oil import reduction levels were developed.)

World Oil Prices During an Oil Production Limitation

Assessing future world oil prices during a supply interruption is quite difficult, due to the wide range of political and economic factors that could affect the price of oil. Although world oil supply and demand conditions during the 1973-74 crisis enabled OAPEC countries to increase the price of oil significantly, if an oil production limitation occurred in the early 1980's current political factors and world oil market conditions make it less likely that world oil prices would skyrocket, as they did in 1973. Several other factors may also constrain the price of oil during another supply interruption. A marked increase in the price of oil would no doubt make many synthetic fuels, which are currently above the world price of oil, economically feasible. In the long run, this development would clearly be disadvantageous to OAPEC; thus, it might constrain the amount of the oil price increase. On the political side of the equation, a significant increase in the price of oil could be more detrimental to Third World countries than to the United States. Although the United States could afford to pay for a dramatic increase in oil prices, many Third World countries could not. As a consequence, OAPEC may not want to absorb the political costs of a dramatic increase in prices.

Nevertheless, this analysis does assume that non-OAPEC oil exporters would marginally increase oil prices, to take advantage of the oil production limitation instituted by OAPEC. Thus, this analysis assumes that world oil prices would remain constant in real terms before a supply interruption in the early 1980's, as they had before the 1973-74 cutback. At the point of the supply interruption, however, oil prices would increase by 20 percent and remain at that level.⁵

Strategic Petroleum Reserve

The 1973-74 Arab oil production cutback and the increasing dependence of the American economy on imported oil led Congress, in the Energy Policy and Conservation Act of December 1975 (EPCA), to mandate the development of a strategic petroleum reserve. In order to expedite development of the SPR, the EPCA legislation provided for an early storage reserve (ESR), which was to be at least 150 million barrels.

EPCA also mandated that the Federal Energy Administration submit a strategic petroleum reserve plan, detailing proposals for

⁵ Alternative oil price assumptions were made to test the sensitivity of the Wharton model. Only when oil prices doubled did the results of the analysis change significantly. For example, a 40-percent increase in oil prices, as opposed to the 20-percent increase used in the analysis, had only a marginal effect on the results.

designing, constructing, and filling the reserve. In February 1977, an SPR plan was submitted to the Congress; it became effective in April of 1977. This plan superseded the ESR plan, but retained the goal of storing 150 million barrels of oil by December 1978.

Concomitantly with the national energy plan, an amendment to SPR was submitted to the Congress on May 29, 1977. This accelerated plan called for the storage of 250 million barrels by December 1978 and of a total of 500 million barrels by December 1980. The administration has also recently requested and received approval for an additional 500 million barrels, which will bring the total crude in storage to 1 billion barrels—the maximum amount authorized in EPCA—by 1985.⁶ About 35 million barrels are in the ground now, according to the latest DOE data.

The SPR is clearly one of the major policy options available to mitigate the effects of an oil supply interruption on the economy. Two SPR levels are assumed in the analytic framework. In the first case, 500 million barrels are assumed to be in storage; in the second case, only 250 million barrels are assumed to be stored. Both cases, however, assume that the oil in the reserve is depleted after 1 year.

Allocation Regulations

During the 1973–74 oil production cutback, the Emergency Petroleum Allocation Act of 1973 (EPAA) led to the development of a system of petroleum allocation regulations, which represented a major part of the Federal Government's response to the supply interruption. In essence, the allocation system distributed petroleum products to particular sectors, with priority going to sectors that protected public health, safety, and welfare and maintained national defense, mineral production, and agricultural operations.⁷

Since the 1973–74 foreign oil supply interruption, the Federal Energy Administration and, later, DOE have engaged in a careful review of the policies pursued during the 1973 oil production cutback. To that end, DOE has funded a number of studies to evaluate the existing priority classification system, and the agency will probably issue a new set of regulations within the next year. A priority classification system developed by Resource Planning Associates (RPA) of Cambridge, Mass., was utilized in all four of the cases analyzed in this report.⁸

Price Controls on Oil

In terms of macroeconomic policy for dealing with the 1973–74 energy crisis, the Nixon administration utilized Phase IV price controls, which were in effect when the crisis occurred. Phase IV was introduced in mid-July of 1973. Except for lifting the freeze in the agricultural sector of the economy, Phase IV regulations allowed most firms to pass through the increased costs only on a dollar-for-dollar, rather than on a percentage, basis. Furthermore, only certain cost increases after the last quarter of 1972 were permitted.

⁶ Since the supply interruption is assumed to take place in the early 1980's, only 500 million barrels are estimated to be in place at that time. The full 1 billion barrels is not likely to be in storage until the mid-1980's.

⁷ Another component of the system included a freeze in supplier-purchaser relations that required allocations beyond crude to be based on a refined product allocation to each marketer or distributor of production. The allocation also had a State set-aside program and a crude oil buy-sell program.

⁸ For more detail on this classification approach, see Resource Planning Associates, "A Revised Priority Classification System for Allocating Petroleum" (December 1977).

Phase IV also included detailed plans for selective decontrol of industries, which began in October 1973. Removal of an industry from regulations was generally based on a commitment by the industry concerning its future price, investment, or industrial relations behavior that would aim at increasing productivity and restraining price increases. Furthermore, prices and wages in an industry were usually decontrolled at the same time. Authority for wage, price, and profit controls ended in late April 1974, when the Economic Stabilization Act expired.⁹ Today, the President has no clear-cut authority to invoke price and wage controls under existing legislation, such as the Defense Production Act, or through the Council on Wage and Price Stability.

Price controls are quite controversial; yet they are one of the major policy options available in a national emergency, such as a foreign oil production limitation and price increase. A modified form of price controls was developed specifically for this analysis. The analysis assumes that these controls would permit prices to increase enough to compensate for increased production costs of petroleum-related products on a dollar-for-dollar basis. Similarly, foreign oil import price increases would also be allowed to pass through the economy.

What are the advantages and disadvantages of this particular form of price controls? One of the major reasons for utilizing price controls in the analytic framework relates directly to the petroleum allocation regulations. Because Congress mandated development of a system for rationing oil to key sectors of the economy in order to prevent producers from making excess profits, some potential benefits of these oil allocation regulations would clearly be negated without a system of price controls on oil. Price controls were also assumed to be in effect because they help prevent a transfer of income away from consumers to producers, which is likely to occur in a petroleum shortfall. In this instance, price controls alleviate some of the disruptive effects of an immediate redistribution of income. Finally, in the short run, price controls on oil-related products may lessen the rate of inflation, although the empirical evidence on this point is not clear cut.

But price controls also have a number of serious limitations. The temporary short-run gains from controls may lead to a higher rate of inflation in the long run, because they suppress the rate of inflation. Price controls may also lead to numerous market inefficiencies and inequities, which would not occur if markets were free to operate. Moreover, in order for controls to work effectively, monetary and fiscal policy must be closely coordinated. Clearly, this did not happen during the 1973-74 crisis, inasmuch as the Federal Reserve did not increase the money supply. Controls are also very difficult to administer and require a large bureaucracy. And, finally, in implementing any form of price controls, it is very difficult to develop a fair set of standards: one that can be readily applied in specific instances as well as in a broad range of cases. Because of these negative factors regarding price controls, the results presented in the next chapter are essentially minimum estimates of the impact on the economy of an oil supply interruption and price increase.

⁹ This discussion on price controls is taken directly from Congressional Budget Office, "Income Policies in the United States: Historical Review and Some Issues" (May 1977).

CHAPTER III. MACROECONOMIC EFFECTS AND POLICY IMPLICATIONS

This chapter summarizes the results obtained from the analysis of the four oil production limitation and price increase cases considered by this report. Each case is compared with a "base case" economic forecast of the 1978-85 economy.¹ The first section of this chapter briefly reviews their short- and long-run effects on real output, unemployment, and inflation. The second section examines the effectiveness of the oil allocation regulations and the strategic petroleum reserve in mitigating those macroeconomic effects.

Before presenting the specific results of the analysis, however, several points that help to keep them in perspective should be noted. All of the cases analyzed in this paper assume a yearlong oil supply interruption, in sharp contrast to the 1973-74 crisis, which lasted less than 6 months.² These cases also assume a 20-percent increase in the real world price of oil, as opposed to the 1973-74 quadrupling of oil prices. Further, the cases considered assume that the composition of final demand is essentially determined through the oil allocation regulations and that price controls on oil are in effect throughout the time period under consideration.

MACROECONOMIC EFFECTS

Effects During the Interruption

As expected, larger petroleum shortfalls lead to larger output losses, greater unemployment, and more rapidly rising prices. As table 2 shows, the 4-year-long oil production limitation cases examined in this report have wide-ranging effects on real GNP.³ For example, in case 1, the smallest petroleum shortfall, real GNP losses relative to the base case would be 2.9 percent. At the other extreme, the largest oil production limitation, case 4, would result in a 9.8-percent decrease in real GNP. The impact of the oil limitation on unemployment closely parallels that of real GNP. In case 1, the unemployment rate would increase by 1 percent over the base case; in case 4, it would increase by 3.2 percent.

The impact of the supply interruptions on prices in the short run is similar to their impact on real GNP and unemployment. For instance, in case 1, the inflation rate would increase 1.3 percent over the base case; in case 4, it would increase by 4.3 percent. These price increases would also affect GNP. Higher prices reduce both real income and the real wealth of households, thereby causing households to reduce purchases of goods and services, which slows real economic growth.⁴

¹ A base case projection is useful for measuring the relative output loads associated with specific supply interruptions. The forecast used in this analysis assumes a growth rate of about 3.6 percent and an inflation rate of slightly more than 6 percent between 1978 and 1985. The unemployment rate is projected to decline to just over 5 percent by 1982 and 4.6 percent by 1985.

² In the 1973-74 oil crisis, about 15 percent of the U.S. petroleum supply was cut off, resulting in a 3-percent reduction in output. See chapter 1 of this paper for more details.

³ Uncertainty as to how conservation measures, fuel switching, the drawdown of the SPR, and the level and drawdown of oil pipeline inventories would mitigate the effect of the production limitation makes it extremely difficult to estimate the precise impact of a briefer supply interruption; hence, the results of the analysis are presented in annual terms. Nevertheless, for an oil production limitation of less than a year, the impact on real output (as well as prices and unemployment) is assumed to be linearly related to the annual results. For example, case 1 would result in a \$22.5 billion loss to the economy in a 6-month supply interruption, as compared with a \$45 billion loss during a yearlong cutback.

⁴ The price controls applied in this analysis permit price increases sufficient to compensate for increased costs of production, which would lead to severe bottlenecks and inefficiencies in the costs of producing all goods and services in the economy. These inefficiencies would obviously be greater at higher levels of oil shortfall, which, in turn, would lead to more rapid increases in prices. A fuller discussion of the interaction between prices and GNP can be found in a number of CBO publications. See for example, "President Carter's Energy Proposal" (1977), chapter 11, and "Recovery How Fast and How Far" (1975), chapter 5.

TABLE 2.—IMPACT OF A YEARLONG OIL PRODUCTION LIMITATION IN 1982 ON GNP, UNEMPLOYMENT, AND INFLATION DURING THE SUPPLY INTERRUPTION¹

[In percent]

Level of oil reduction and of strategic petroleum reserve	Resulting petroleum shortfall ²	Change in real GNP ³ (billions of dollars)	Change in GNP	Change in unemployment rate	Unemployment rate in 1982 with oil limitation	Change in inflation rate
Case 1, 3,000,000 bbl/d oil reduction, 500,000 bbl SPR.....	8	-45	-2.9	+1.0	6.1	+1.3
Case 2, 3,000,000 bbl/d oil reduction, 250,000 bbl SPR.....	11	-65	-4.1	+1.4	6.5	+1.8
Case 3, 4,000,000 bbl/d oil reduction, 500,000 bbl SPR.....	13	-112	-7.1	+2.3	7.4	+3.0
Case 4, 4,000,000 bbl/d oil reduction, 250,000 bbl SPR.....	16	-155	-9.8	+3.2	8.3	+4.3

¹ As compared with the baseline economic forecast.² Represents the amount of petroleum lost to the economy during the interruption, after accounting for SPR.³ GNP is in 1972 dollars.*Effects After the Interruption*

In the 3-year period following the oil production limitation, the economy would rebound substantially, with real output increasing, unemployment declining, and price increases subsiding. But all of these key macroeconomic indicators are still at variance with the base case forecast for 1985: Real GNP would be below the forecast level and the unemployment and inflation rates would be higher.

More specifically, as Table 3 illustrates, real output by 1985 would remain .72 to .82 percent below the base case forecast. Similarly, the unemployment rate in 1985 would continue to remain above the base case forecast (by .5 to 1 percent) in all four of the cases examined. Price increases in each case would also remain above the baseline forecast in 1985, but the smallest oil production limitation would have a slightly lower rate of inflation. The slightly lower rates of inflation for the larger supply interruptions is the result of their higher rates of unemployment, which tend to suppress price increases.

TABLE 3.—IMPACT OF A YEARLONG OIL PRODUCTION LIMITATION IN 1982 ON REAL GNP, UNEMPLOYMENT, AND INFLATION IN 1985¹

[In percent]

Level of oil reduction and of strategic petroleum reserve	Resulting petroleum shortfall ²	Change in real GNP ³ (billions of dollars)	Change in GNP	Change in unemployment rate	Unemployment rate in 1985 with oil limitation	Change in inflation rate
Case 1, 3,000,000 bbl/d oil reduction, 500,000 bbl SPR.....	8	-12.6	-0.72	+0.5	5.1	+0.68
Case 2, 3,000,000 bbl/d oil reduction, 250,000 bbl SPR.....	11	-12.8	-.73	+.6	5.2	+.55
Case 3, 4,000,000 bbl/d oil reduction, 500,000 bbl SPR.....	13	-13.7	-.78	+.8	5.4	+.32
Case 4, 4,000,000 bbl/d oil reduction, 250,000 bbl SPR.....	16	-14.2	-.82	+1.0	5.6	+.13

¹ As compared with the baseline economic forecast.² Represents the amount of petroleum lost to the economy during the interruption, after accounting for SPR.³ GNP is in 1972 dollars.

IMPACT OF SPR AND PETROLEUM ALLOCATION REGULATIONS

Significant losses in real output could be averted through the strategic petroleum reserve. Table 4 vividly illustrates the benefits of the SPR.

Comparison of a 250- and 500-million-barrel SPR in a 3-mmbd production cutback indicates that the additional 250 million barrels in the ground would save \$20 billion in real output (\$65 minus \$45 billion). In this case, there is a net 1.2-percent savings in real GNP from the base case. Thus, on the margin, \$80 in output loss is averted per SPR barrel in the ground during a 3-mmbd supply interruption with a 500-million SPR.⁵

In the 4-mmbd oil supply interruption, the total output loss averted by an additional 250-million barrel SPR is even more striking. As Table 4 indicates, about \$43 billion in real output loss—more than twice the SPR savings in the 3-mmbd supply interruption—would be averted, representing a net 2.7-percent savings in real GNP relative to the base case forecast. A 500-million barrel SPR with a 4-mmbd oil production cutback would save \$172 per barrel in real GNP, as compared with \$80 in the 3-mmbd case. In short, although the SPR is effective in preventing output losses under the conditions assumed for this analysis in both supply interruption cases, it is clearly more effective in averting output at higher levels of oil shortfall.

TABLE 4.—IMPACT OF STRATEGIC PETROLEUM RESERVE (SPR) ON REAL GNP DURING A 3,000,000 AND 4,000,000 BBL PER DAY OIL SUPPLY INTERRUPTION IN 1982¹

Level of SPR	3,000,000 bbl per day		4,000,000 bbl per day	
	Change in real GNP ² (in billions of dollars)	Percent change in GNP	Change in real GNP ² (in billions of dollars)	Percent change in GNP
250,000,000 barrels.....	-65	-4.1	-155	-9.8
500,000,000 barrels.....	-45	-2.9	-112	-7.1

¹ As compared with the baseline economic forecast.

² GNP in 1972 dollars.

Another perspective on the impact of the SPR can be gained from Table 5, which shows the effect of the reserve on the unemployment rate. In the 3-mmbd supply interruption, the additional 250 million barrels of the reserve would reduce the unemployment rate from 6.5 to 6.1 percent. By taking about four-tenths of 1 percent off the unemployment rate in 1982, about 430,000 workers could be kept from unemployment.

In the 4-mmbd case, the 500-million SPR would reduce the unemployment rate by 0.9 percent (3.2 minus 2.3 percent), which is slightly more than twice the 3-mmbd case. This implies that an SPR of 500 million barrels would keep approximately 960,000 workers employed. It should be noted, however, that even with a reserve of 500 million barrels, an annual unemployment rate of 8.3 percent in 1982 would be very high for the postwar era.

⁵ The marginal benefit per barrel is determined by dividing the additional benefit of \$20 billion in the 3-mmbd case by the additional 250 million barrels associated with a 500-million-barrel reserve. The same procedure was carried out in the 4-mmbd case (\$43 billion, or \$155 minus \$112 billion, divided by 250 million barrels).

These results indicate that the strategic petroleum reserve is an effective policy option for mitigating the output losses that are likely to occur during an oil production cutback. Several key points concerning its effectiveness can be summarized. First, the reserve appears to be more useful in reducing output losses at higher levels of oil shortfall. Second, the marginal benefit—in terms of output loss averted—of increasing the reserve from 250 to 500 million barrels in both the 3- and 4-mmbd supply interruption is significant.

TABLE 5.—IMPACT OF STRATEGIC PETROLEUM RESERVE ON UNEMPLOYMENT DURING A 3,000,000 AND 4,000,000 BBL PER DAY OIL SUPPLY INTERRUPTION IN 1982

Level of SPR	[In percent]			
	3,000,000 bbl per day		4,000,000 bbl per day	
	Change in unemployment rate ¹	Unemployment rate in 1982	Change in unemployment rate ¹	Unemployment rate in 1982
250,000,000 barrels.....	+1.4	6.5	+3.2	8.3
500,000,000 barrels.....	+1.0	6.1	+2.3	7.4

¹ As compared with the baseline economic forecast of 5.1 percent unemployment.

Despite those benefits, it is important to note that final assessment of the effectiveness of this policy option must be balanced against both its cost (the 500-million SPR will cost around \$8 billion) and the probability of the occurrence of another oil production limitation and price increase. The actual value of the strategic petroleum reserve to the Federal Government can be estimated only by doing a form of risk analysis. Moreover, the probability of another oil production limitation cannot be determined.

Effectiveness of Petroleum Allocation Regulations

Several observations about the petroleum allocation regulations can be made as a result of the analysis of the impact of the various oil production limitation and price increase cases on key sectors of the economy. Of prime importance from a policy perspective is the finding that the higher priority sectors generally lose proportionately less output than the lower priority sectors. The relative advantage of the high priority sectors, however, depends on the magnitude of the oil limitation facing the economy. In addition, certain sectors of the economy, such as finance, insurance, and real estate, sustain the smallest output loss on a percentage basis because these sectors consume very little petroleum; hence, they are relatively insensitive to supply reduction.⁶

In the smallest petroleum shortfall, relatively minor changes in output take place in the sectors that constitute the higher priority industries, as compared with those constituting the lower priority industries (see Table 6). For example, communications, utilities, agriculture, and mining experience small output reductions, while durables, nondurables, and the wholesale and retail trade undergo significantly larger output losses. This result holds for all of the cases, at both high and low levels of oil shortfall, because durables, nondurables, and the

⁶ Several points should be noted in interpreting the data in this section. First, the relative sector effects are essentially determined by the criteria selected by RPA for the allocation regulations, which are consistent with EPAA of 1973. Second, the impact of alternative petroleum allocation regulation plans on total GNP and on the distribution of GNP has not been reviewed.

wholesale/retail sectors continue to absorb the largest output losses while vital sectors undergo proportionately less output loss.

The data also indicate that at higher levels of oil shortfall—around 15 percent—significant changes in both output loss and rates of decline occur in most sectors. This finding indicates that at some intermediate level of supply interruption, further oil reductions cannot be absorbed as efficiently as smaller reductions. This, of course, varies by sector.

Thus, through the allocation regulations, sectors of the economy defined by Congress in the Emergency Petroleum Allocation Act of 1973 as vital to the national interest generally do not suffer output losses as large as those in other sectors. More specifically, such vital sectors as agriculture, mining, utilities, and communications suffer proportionately less output loss than durable and nondurable goods, contract construction, and wholesale and retail sales. Allocation regulations of this kind thus help make the composition of final demand during a foreign oil supply interruption compatible with the national interest, as defined by the Congress.

TABLE 6.—IMPACT OF AN 8-PERCENT PETROLEUM SHORTFALL IN 1982 ON MAJOR SECTORS OF THE ECONOMY DURING THE SUPPLY INTERRUPTION: IN PERCENTS

Rank	Sector	Output loss ¹
1	Financial, insurance, real estate.....	1.17
2	Utilities.....	1.45
3	Communications.....	1.72
4	Mining.....	2.24
5	Agriculture.....	2.55
6	Services.....	2.59
7	Construction.....	2.91
8	Transportation.....	3.46
9	Wholesale/retail.....	3.92
10	Nondurables.....	4.30
11	Durables.....	6.34

¹ As compared with the baseline economic forecast.

In sum, although this analysis indicates that another oil limitation and price increase would significantly affect the American economy, both the strategic petroleum reserve, which would reduce output losses, and a system of petroleum allocation regulations, which would help insure the production of vital national goods and services, would help minimize the resulting output loss and inflation.

APPENDIXES

APPENDIX A

Description of the Wharton Annual Energy Model

DESCRIPTION OF THE WHARTON ANNUAL ENERGY MODEL

INTRODUCTION

Input-output analysis offers one of the most effective techniques for studying the relation between the size of a petroleum shortfall and aggregate economic activity because it allows the direct as well as the indirect effects of the shortfall on output to be captured.

Applying conventional input-output analysis alone to the study of a supply interruption does, however, have some disadvantages. First, conventional input-output analysis assumes fixed technologies and prices; no substitution among inputs is allowed. Second, although it permits the determination of industrial deliveries to final demand, it does not determine the distribution of these deliveries by GNP component—that is, consumption, investment, public expenditures, and net exports. Third, it does not recognize inherent output restrictions, which exist in such industries as oil and gas.

These problems can be resolved by combining conventional input-output analysis with a framework which permits input substitution, distributes industrial deliveries to final demand across the GNP components, and restrains oil and gas output. The Wharton Annual Model (Energy Version), which combines input-output analysis with a macroeconomic model, eliminates many of the shortcomings of conventional input-output analysis.

In studying the impact of petroleum import shortfalls, the Wharton Annual Energy Model is "solved backwards." Restrictions on industrial output, as determined by the Resource Planning Associates (RPA) allocation regulations, restrain the gross output of the model's 63 industrial sectors. The input-output table is then used to determine the feasible set of deliveries to final demand.¹ By comparing the "feasible" set of deliveries to final demand with the set required by the existing final demand composition, necessary allocation adjustments to final demand are determined. The purpose of those adjustments is to eliminate excess demand for the output of each industrial sector. This procedure is repeated until the final demands are consistent with the constrained output.

The presence of excess demand in the system is an obvious source of inflation during an oil production cutback. The model is structured to allow these inflationary surges to either be passed through to the general price level and wages or, alternatively, to be suppressed. The latter option posits the existence of price restraints to prevent primary prices from adjusting because of excess demand.

INPUT-OUTPUT ANALYSIS OF A FOREIGN OIL PRODUCTION CUTBACK

Consider an input-output model of a fictitious three-industry economy consisting of agriculture, steel, and oil (see Table A-1). Each column provides a list of the inputs needed for the production of an industrial good. For example, for each \$100 of oil output, \$25 of input is required from the steel industry, and \$65 in labor and capital inputs. Each row gives the distribution of an industry's output. Again, for the oil industry, \$35 are delivered to the agricultural industry, \$50 to steel, \$10 to oil, and \$15 to final demand. For each industry, the row/column sum equals the total gross value of output for that sector.

TABLE A-1.—SIMPLE INPUT-OUTPUT ACCOUNTING EXAMPLE

[In dollars]

	Agriculture	Steel	Oil	Industrial deliveries to final demand	Gross output
Agriculture.....	50	0	0	100	150
Steel.....	25	100	25	50	200
Oil.....	25	50	10	15	100
Value added.....	50	50	65	165	
Gross output.....	150	200	100		450

Note: $GNP = \Sigma \text{ value added} = \Sigma \text{ industrial deliveries to final demand} = 165$.

¹ The appropriate starting point is the final demand distribution that would exist in the absence of a production cutback.

TABLE A-2.—SIMPLE INPUT-OUTPUT ACCOUNTING EXAMPLE WITH EXPANDED FINAL DEMAND
[In dollars]

	Intermediate inputs			Final demand			
	Agriculture	Steel	Oil	Consumption	Net exports	Other	Gross output
Agriculture.....	50	0	0	80	10	10	150
Steel.....	25	100	25	0	50	0	200
Oil.....	25	50	10	10	5	0	100
Value added.....	50	50	65				
GNP components.....				90	65	10	
Gross output.....	150	200	100				450

Note: GNP = Σ value added = Σ GNP components = 165.

Now, consider the same example, except the single final demand category is broken down into three categories: consumption, net exports, other final demands (see Table A-2). Both the summation of the value added and the summation of the GNP components yield GNP.

If the intermediate sector column recipes are divided by the gross output of the sector, the proportions for \$1 of gross output are obtained (see Table A-3). Similarly, if each component of final demand is divided by its column total, the industrial distribution of \$1 of each category of final expenditure is obtained.

TABLE A-3.—SIMPLE INPUT-OUTPUT TABLE IN COEFFICIENT FORM

	Agriculture	Steel	Oil	Consumption	Net exports	Other
Agriculture.....	0.33	0	0	0.89	0.15	1.00
Steel.....	.17	.50	.25		.77	
Oil.....	.17	.25	.10	.11	.08	
Value added.....	.33	.25	.65			
GNP components.....				1.00	1.00	1.00
Gross output.....	1.00	1.00	1.00			

Finally, the basic form shown in Table A-3 can be redefined. Figure A-1 shows the basic structural elements of the single table. In solving the Wharton annual model, a vector of GNP components is first determined (the G vector). The H matrix (or bridge matrix) translates the final demands by GNP component into final demands by the industrial sector (the F vector). The technology matrix (or A matrix) then translates the F vector into gross output by industry (the X vector). Value added is determined by fractioning the gross output into intermediate and primary inputs.

Figure A-1.

Basic Input-Output Structure

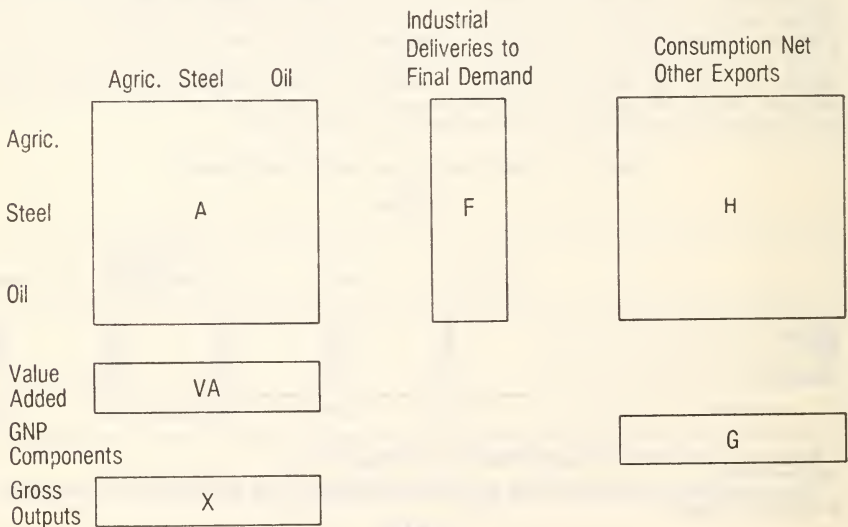


Figure A-2.

Direction of Solution of Input-Output Relationships

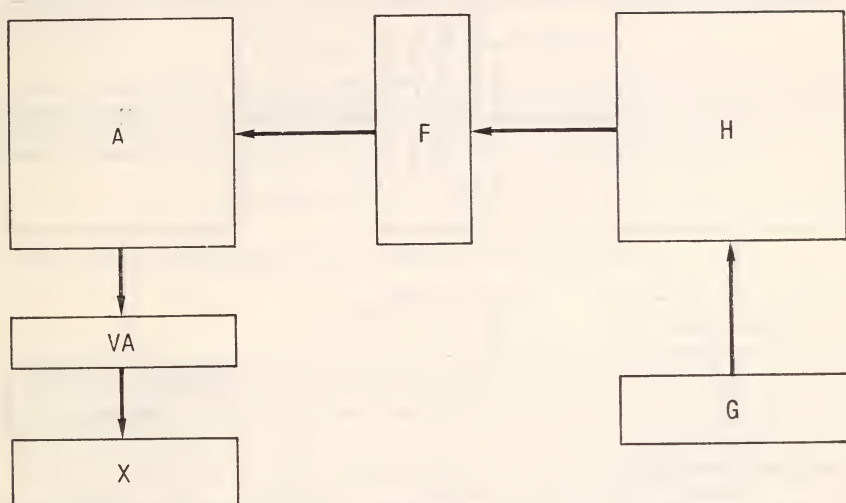


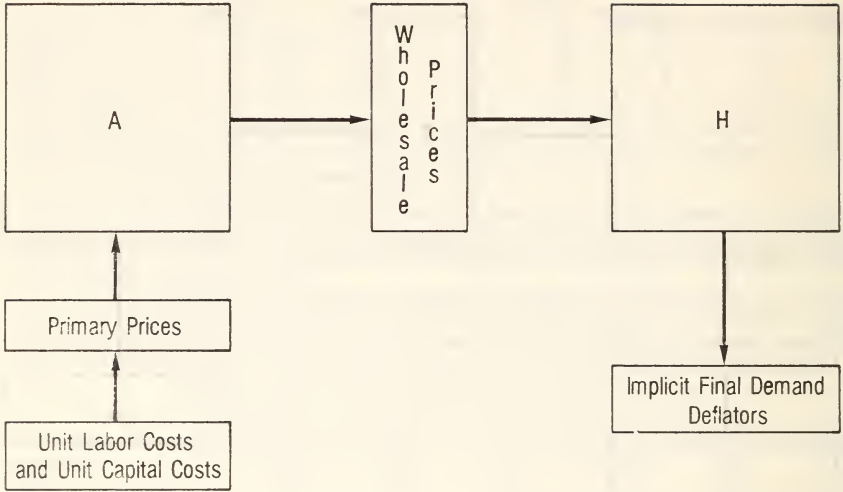
Figure A-2 shows the direction of solving the input-output relation—translating final demands into industry output requirements. The difficulty with solving the model using this standard procedure to study the impact of an oil production cutback is that restrictions will be applied to industrial outputs. This means that rather than using the composition of final demand to determine the composition of industrial output, to some degree, industrial outputs are predetermined by the RPA petroleum allocation regulations. Defining XE to be the vector of constrained gross outputs induced by the oil production cutback, Figure A-2 must then be solved “backwards.” Thus, a new set of final demands must be derived, given XE.² Although the industrial deliveries to final demand can be determined in a rather straightforward manner, given the technology, a difficulty in implementing this step arises because no unique relation exists between the industrial deliveries vector, F, and the vector of GNP components, G.

There are several ways to circumvent the indeterminacy problem of directly translating the industrial deliveries vector into the final demand components. One way, used in several earlier studies of oil production cutbacks, is to reduce final demand through some ad hoc procedure until the output constraints are satisfied. An alternative methodology, however, was developed for this study. The basis for the methodology can be summarized by examining Figure A-3, which shows the direction of price conversion in the model. Prices are built up from both unit labor and capital costs, which in turn determine gross output prices. The gross output prices are then used to determine the implicit final demand deflators. The direction of price conversion in the model parallels the direction of the oil production cutback solution—from the output side, back to final demand.

² XE is derived by utilizing the RPA allocation schemes

Figure A-3.

Direction of Solution of Price Relationships

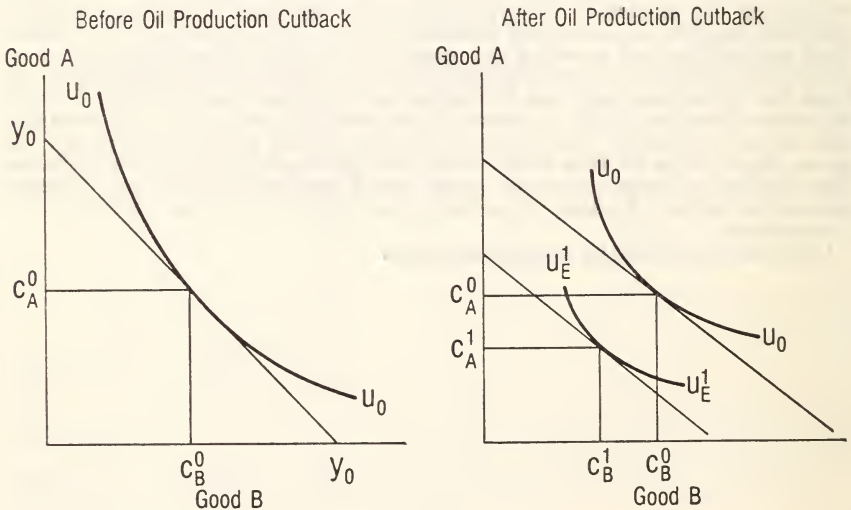


Before describing how new excess demand is translated into price adjustments, it is useful to discuss first how the constraints on industrial output affect the level and composition of final demand. The adjustment of final demand can be broken down into an income effect and a price effect.

The income-price effects are summarized in Figure A-4. If we are dealing with just two goods, A and B, let U_0, U_1 represent the pre-oil production cutback indifference curve. Line Y_0, Y_1 is the pre-oil production cutback budget line; the slope of the budget line is determined by the relative prices for A and B. Now assume that income is reduced in the oil production cutback to Y_E, Y_E . A reduced level of consumption of goods, A and B results.³ The relative prices of A and B can then be adjusted to eliminate excess demand for industrial deliveries to final demand.

Figure A-4.

Income and Price Effects



³ This assumes that neither good is inferior.

Price adjustment due to excess demand can be treated in two ways. The methodology can best be explained by writing out the basic relationship for determining gross output prices:

Gross output price sector j equals value added deflator sector j plus material input prices.

$$PWPI_{\phi_j} = \gamma * PVA_j + \sum_i a_{ij} * PWPI_i$$

This relation states that the weighted sum of the primary input price for an industrial sector plus the material input prices yields the gross output price for a sector. This relation is modified in the production cutback period to account for excess demand for the sector's output. The revised specification reads:

$$PWPI_{\phi_j} = \gamma * PVA_j + \sum_i a_{ij} * PWPI_i + \Delta_j$$

Where the additional term, Δ_j , is determined by the relation:

$$\Delta_j = \left[\frac{FE_j - F_j}{F_j} \right]^{e_j}$$

That is, α_j represents the adjustment to prices due to the reduction in deliveries to final demand. The term, e_j , is an elasticity—the fraction of the percentage shortfall in deliveries that is passed into gross output prices. By assumption, the e_j was set to 0.5.

Alternatively, the Δ_j term can be suppressed. The argument is that price controls permit price increases only sufficient to compensate for increased costs of production. But a mechanism is required to adjust the allocation of final demand. The methodological approach is to bypass the model's normal price channels and transmit the allocational information to final demands by way of "shadow prices"; that is, although the aggregate price level is not affected, relative prices are. The final demands are adjusted by the relation:

$$FD_j^* = FD_j \left(\frac{P_{embargo}}{P_{preembargo}} \right)^j$$

where FD_j^* , is the final demand for category j after adjustment for changes in relative prices due to the production cutback. This α_j term is an elasticity parameter. These terms are assumed for each component of final demand.

This discussion has greatly simplified the price-income effects, but the main thrust of the argument is that the proposed methodology systematically solves for a feasible final demand set. The RPA allocation plan determines XE , the constrained set of gross outputs. Given XE , a vector of industrial deliveries to final demand, FE , can be determined. Using an initial estimate for final demand, G , a corresponding required deliveries vector, F , can be obtained. By comparing the two vectors— FE and F —on a sector-by-sector basis, an excess demand vector is derived. This is used to revise the gross output prices for each industrial sector. In turn, the revised gross output prices adjust final demand prices. For each final demand category, then, a revised estimate is obtained by comparing the constrained and unconstrained final demand prices. This methodology permits either the pass-through of excess demand inflationary shocks or the suppression of those shocks by some form of price controls.

APPENDIX B

Development of Assumptions Regarding Oil Import Reduction Levels

DEVELOPMENT OF ASSUMPTIONS REGARDING OIL IMPORT REDUCTION LEVELS

The four scenarios analyzed in this report assume yearlong oil import reductions of 3 or 4 million barrels a day, with the OAPEC nations again instituting a production cutback. These oil import reduction levels were developed by assessing forecasts of future U.S. oil imports, the OAPEC share of U.S. oil imports, and the international reserve position of the key OAPEC countries. These factors, each one of which is discussed below, were then combined to develop plausible assumptions concerning the level of a future oil import cutback.

FORECAST OF FUTURE U.S. OIL IMPORTS

In developing the assumptions regarding future oil import levels, six recent studies of U.S. energy supply and demand, employing a wide range of methodologies and assumptions, were reviewed.¹

Despite differences in method of analysis, all conclude that U.S. oil imports in the early 1980's will range between 9 and 11 million barrels a day. Hence, while each of the studies is subject to a great deal of uncertainty, together, they provide a reasonable range of future oil imports, which effectively bounds the import range for the United States in the early 1980's.

OAPEC SHARE OF U.S. IMPORTS

As Table B-1 illustrates, OAPEC's share of total U.S. oil imports has increased substantially since the 1973-74 oil production cutback.

TABLE B-1.—OAPEC SHARE OF U.S. OIL IMPORTS

[In thousands of barrels a day]

Year	Total U.S. oil imports	OAPEC imports	OAPEC imports as a percent of total imports
1973.....	6,256	1,377	22
1974.....	6,112	1,106	18
1975.....	6,056	1,790	30
1976.....	7,313	2,773	38
1977.....	8,696	3,693	42

Source: U.S. Department of Energy, Monthly Energy Review (July 1978).

OAPEC imports decreased from 1973 to 1974, primarily because of the oil production cutback, but its share of total U.S. oil imports has grown since 1974. In 1977, OAPEC totaled 42 percent of all U.S. oil imports. Within OAPEC, the major suppliers of oil imports to the United States are Saudi Arabia (42 percent), Libya (23 percent), Algeria (16 percent), and the United Arab Emirates (12 percent). Kuwait, Iraq, Qatar, and several other smaller countries combine for about 7 percent of all OAPEC imports to the United States.

¹ These studies included: U.S. Department of Energy, "Projections of Energy Supply and Demand and Their Impacts" (1978); Petroleum Industry Research Foundation, "Outlook for World Oil Into The 21st Century" (1978); Congressional Research Service, "Project Interdependence: U.S. and World Energy Outlook Through 1990" (1977); Organization for Economic Cooperation and Development, "World Energy Outlook" (1977); Central Intelligence Agency, "Major Developed Countries: Changing Trade Flows and Increasing Vulnerability in 1982" (1977); and Irving Trust Co., "International Oil Revisited: Could The Experts Be Wrong?" (1977).

This analysis assumes that the OAPEC share of total U.S. oil imports in 1982 would range between 35 and 43 percent. That range both captures our most recent historical experience and takes into account a variety of likely future developments affecting OAPEC's future share of U.S. oil imports.

FINANCIAL CONDITION OF OAPEC COUNTRIES

A yearlong oil production cutback could clearly have an adverse financial impact on a number of OAPEC nations, which could conceivably limit the participation of particular countries. To assess the ability of the major OAPEC countries to sustain a yearlong production cutback, their international reserves and the ratio of reserves to imports were reviewed on a country-by-country basis.

The financial condition of all OAPEC countries appears to have improved since 1973 (see Table B-2). Further, these reserve estimates reflect only public holdings and do not include the private reserves of individual Arab monarchs or families.² Nevertheless, assessment of this increase in reserves should be balanced by the fact that, since 1973, almost all of these countries have begun large-scale development projects, which require substantial capital.

TABLE B-2.—FINANCIAL CONDITION OF OAPEC COUNTRIES, 1973 AND 1977

[In millions of U.S. dollars]

Country	Financial reserves		Imports		Ratio of reserves to imports	
	1973	1977 ¹	1973	1977	1973	1977
Saudi Arabia.....	3,877	27,784	1,840	2,935	2.11	9.46
United Arab Emirates.....	92	1,798	744	989	.12	1.82
Libya.....	2,127	3,087	1,838	1,061	1.16	2.91
Algeria.....	1,143	2,193	2,129	1,148	.54	1.91
Kuwait.....	501	1,831	910	953	.55	2.01
Iraq.....	1,553	5,070	817	490	1.90	10.35
Qatar.....	76	² 137	176	2251	.43	² 54

¹ 1st quarter of 1977.

² 4th quarter of 1976.

Source: International Monetary Fund, International Financial Statistics (April 1978).

Table B-2 suggests that during a lengthy production cutback some OAPEC countries (such as Qatar, Libya, or Algeria, which together currently account for 40 percent of OAPEC oil imports to the United States) might have some financial difficulties. Thus, in view of the likelihood that these countries and some smaller OAPEC countries might have to limit their participation in the production cutback because of their need for foreign exchange, the analytical framework developed in this paper reduced the magnitude of the Arab oil production cutback.

OIL IMPORT REDUCTION LEVELS

As the preceding analysis has indicated, a range of factors could affect the size of the Arab oil production cutback. This section considers those factors and concludes that two conservative yet plausible import reduction levels are 3 and 4 million barrels a day.

Three-million-barrel-a-day-case.—A 3-mmbd oil production cutback, which represents a "best case" for this analysis—that is, the lowest level of U.S. oil imports—can be developed in a number of ways. Table B-3 illustrates two of the ways in which the 3-mmbd estimate can be derived.

TABLE B-3.—DERIVATION OF 3,000,000 BBL PER DAY CASE

Level of U.S. imports (million barrels per day)	OAPEC share of U.S. imports (in percent)	OAPEC financial limitation (in percent)	Total OAPEC cutback (million barrels per day)
9	35	5	3
9	40	15	3

² In addition, it is likely that almost all of the Arab States involved in the production cutback could expect to obtain needed capital by borrowing from either international banking institutions or from richer OAPEC countries, such as Saudi Arabia.

The 9-mmbd level of U.S. imports was used in both of these cases. The OAPEC share of U.S. oil imports was, however, varied: in one case, OAPEC is assumed to contribute 35 percent; in the other case, 40 percent. Thus, for example, multiplying the 9 mmbd by the 35 percent OAPEC import factor yields imports of 3.15 mmbd. But the analysis also assumes that a combination of smaller OAPEC countries, headed by Qatar, would be forced to limit its participation by 5 percent, which would reduce the oil production cutback to about 3 mmbd. Similarly, for the other 3-mmbd case, one of the large OAPEC countries, such as Algeria or Libya, is assumed to limit its participation, causing a further (15 percent) reduction in the production cutback.³

Although a number of alternative assumptions can be made with respect to the key factors affecting the magnitude of the oil production cutback, the 3-mmbd figure, which can be derived in a number of ways, is a reasonable "best case" estimate.

Four-million-barrel-a-day case.—The 4-mmbd case, which represents a "worst case"—the highest level of U.S. oil imports—was developed in the same fashion as the 3-mmbd case (see Table B-4).

TABLE B-4.—DERIVATION OF 4,000,000 BBL PER DAY CASE

Level of U.S. imports (million barrels per day)	OAPEC share of U.S. imports (in percent)	OAPEC financial limitation (in percent)	Total OAPEC cutback (million barrels per day)
11	38	5	4
11	43	15	4

The major difference in this case is that both a higher level of U.S. oil imports (11 mmbd) and a higher range of the OAPEC share of U.S. imports (38–43 percent) are assumed. However, the same factors used to capture the reduction in particular OAPEC countries participating in the cutback because of financial strain were used again. Obviously, all of these factors could be combined in a variety of ways and the same result could be achieved. The intent of the analysis, however, is to provide a reasonable "worst case" oil import reduction level in order to effectively bound the magnitude of the oil supply reductions.

³ For all of these cases, the United States is assumed a priori to meet its commitment to the International Energy Agency.

